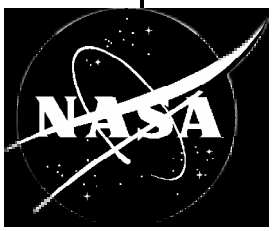
540-094

MISSION OPERATIONS AND DATA SYSTEMS DIRECTORATE

Interface Control Document (ICD) Between the Earth Observing System (EOS) Data and Information System (EOSDIS) Backbone Network (EBnet) and the Flight Software Testbed (FSTB)

September 1997



National Aeronautics and Space Administration

Goddard Space Flight Center
Greenbelt, Maryland

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September 1997

Prepared Under Contract NAS5-31500
Task Assignment 46 505

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540-094

Preface

This document is under the configuration management of the National Aeronautics and Space Administration (NASA) Communications (Nascom) Division Configuration Control Board (CCB).

Proposed changes to this document shall be submitted to the Nascom CCB, along with supportive material justifying the change. Changes to this document shall be made by Document Change Notice (DCN) or by complete revision.

Questions concerning this document and proposed changes shall be addressed to:

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Abstract

This interface control document (ICD) describes interface agreements between the Flight Software Testbed (FSTB) and the Earth Observing System (EOS) Data and Information System (EOSDIS) Backbone Network (EBnet).

Keywords: *EBnet, Flight Software Testbed, FSTB, ICD, interface control document*

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Document History			
Document Number	**Status/Issue**	**Publication Date**	**CCR Number**
540-094	DCN 001	September 1997	505-01-36-019

DCN Control Sheet

DCN Number	Date/Time Group (Teletype Only)	Month/ Year	Section(s) Affected	Initials
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Section 1. Introduction

1.1 Authority and Responsibility

The Mission Operations and Data Systems Directorate (MO&DSD) has the authority to implement the Earth Observing System (EOS) Data and Information System (EOSDIS) Backbone Network (EBnet). This authority was granted to MO&DSD by the EOS project under the Office of Mission to Planet Earth (Code Y). The EBnet project is under the National Aeronautics and Space Administration (NASA) Communications (Nascom) Division of the MO&DSD.

Code 540 will provide an operational communications network to support high-speed network communications between EBnet and non-EBnet hosts. The primary responsibility for this project has been assigned to the Nascom Division, Code 540. The system requirements are documented by the references in Section 2.1.

1.2 Purpose

The purpose of this document is to provide a detailed definition of the interface(s) between the EBnet and the Flight Software Testbed (FSTB).

1.3 Scope

This document defines and specifies the data transport interfaces (i.e., protocols, standards applied, physical connections, and locations connected) between EBnet and the FSTB.

1.4 Time Frame

This Interface Control Document (ICD) shall be in effect from the date of approval by the Nascom CCB and the Chief of the Nascom Division, and when all applicable signatures are obtained.

1.5 Goals and Objectives

The goals of EBnet are to:

a. Implement an operational, integrated, transparent communications system that serves the data communications needs of projects supported by NASA Goddard Space Flight Center (GSFC), and users outside the MO&DSD.

b. Expand using industry standard system solutions while maintaining compatibility with the existing network and user interfaces.

c. Minimize costs for implementation, operation, and maintenance of the network.

d. Minimize life-cycle costs.

e. Maintain high availability by designing with redundancy, and without single points of failure in the Network Backbone, where required.

f. Utilize state-of-the-art technology, utilizing equipment with the best price-performance available commercially.

g. Allow for growth, adaptability to changing requirements, infusion of new technology, and upgraded interfaces throughout the life-cycle.

1.6 Standards Precedence

EBnet will be based on Government, commercial, and international standards. In case of conflict, the following precedence (in descending order) applies:

- This EBnet ICD.
- Government standards.
- Commercial and/or international standards.

1.7 Document Organization

Section 2 contains parent, applicable, and reference documents related to this ICD.

Section 3 details a systems overview of EBnet, FSTB, and the interrelationship.

Section 4 presents an interface detailed design.

Section 5 describes the facilities and maintenance demarcation.

A list of abbreviations and acronyms is provided at the end of the document.

Section 2. Related Documentation

2.1 Parent Documents

[1] *Earth Observing System AM-1 Detailed Mission Requirements*, Goddard Space Flight Center (GSFC), 505-10-33, November 1996

[2] *Earth Science Data Information System (ESDIS) Project Level 2 Requirements Volume 6, EOSDIS Backbone Network (EBnet) Requirements*, Goddard Space Flight Center (GSFC) 505-10-01-6, Revision A, December 1996

[3] *Earth Observing System (EOS) Data and Information System (EOSDIS) Backbone Network (EBnet) Interface Requirements Document (IRD)*, September 1997

[4] Reserved

2.2 Applicable Documents

[5] *Electrical Characteristics of Balanced Voltage Digital Interface Circuits*, Electronic Industries Association (EIA) 422-A, December 1978

[6] *General-Purpose 37-Position and 9-Position Interface for Data Terminal Equipment and Data Circuit-Terminating Equipment Employing Serial Binary Data Interchange*, EIA 449, November 1977

[7] *Internet Protocol (IP): DARPA Internet Program Protocol Specification*, Request for Comment (RFC) 791, September 1981

[8] *The Point-to-Point Protocol (PPP)*, RFC 1661, July 1995

[9] *An Ethernet Address Resolution Protocol or Converting Network Protocol Addresses to 48-bit Ethernet Addresses for Transmission on Ethernet Hardware*, RFC 826, November 1982

[10] *Internet Control Message Protocol*, RFC 792, September 1981

[11] *Routing Information Protocol (RIP)*, RFC 1058

[12] *Open Shortest Path First (OSPF)*, RFC 1247

[13] *Internet Group Multicast Protocol (IGMP)*, RFC 1112

[14] *On the Assignment of Subnet Numbers*, RFC 1219

[15] *Simple Network Management Protocol (SNMP)*, RFC 1157

[16] *Address Resolution Protocol (ARP)*, RFC 826

[17] *A Reverse Address Resolution Protocol (RARP)*, RFC 903

[18] *Internet Protocol on Ethernet Networks*, RFC 894

[19] *Transmission of IP over FDDI*, RFC 1188

[20] *Structure of Management Information*, RFC 1155

[21] *Management Information Base - II*, RFC 1213

[22] *Transmission Control Protocol*, RFC 793

[23] *Telnet Protocol*, RFCs 854 & 855

[24] *File Transfer Protocol*, RFC 959

[25] International Organization for Standardization (ISO) 9314-1, *FDDI Physical Layer Protocol (PHY)*

[26] ISO 9314-2, *FDDI Media Access Control (MAC) Protocol*

[27] ISO 9314-3, *FDDI Physical Layer Medium Dependent (PMD)*

[28] ISO 8802-2, *Logical Link Control (LLC)*

[29] ISO 8802-3, *Carrier-Sense Multiple-Access with Collision Detection (CSMA/CD) Media Access Control (MAC) - Ethernet version 2*

[30] Institute of Electrical and Electronic Engineers (IEEE) 802.3 *10Base-T (twisted pair)*

[31] IEEE *10Base5 (thick ethernet)*

[32] International Telegraph and Telephone Consultative Committee (CCITT) *V.35*

2.3 Reference Documents

[33] *NASA Communications (Nascom) Access Protection Policy and Guidelines*, 541-107, Revision 3, GSFC, November 1995

[34] *NASA Communications System Acquisition and Management*, NASA Management Instruction (NMI) 2520.1D, National Aeronautics and Space Administration (NASA), November 18, 1991

[35] *Nascom IONET Users Guide*, 541-225, Revision 1, April 1996

Section 3. Systems Overview

3.1 EBnet General System Description

The EBnet provides wide-area communications circuits and facilities between and among various EOS Ground System (EGS) elements to support mission operations and to transport mission data between EOSDIS elements. The relationship of EBnet to other elements supporting EOS is shown in Figure 3-1. EBnet is responsible for transporting spacecraft command, control, and science data nationwide on a continuous basis, 24 hours a day, 7 days a week. The EBnet capability to transport those two diverse types of data is implemented as two distinct subnetworks referred to as "real-time" and "science" networks. The real-time network transports mission-critical data related to the health and safety of on-orbit space systems and raw science telemetry as well as prelaunch testing and launch support. This highly redundant network provides an operational availability of 0.9998 with a Mean Time to Restore Service (MTTRS) of 1 minute. The science network transports data collected from spacecraft instruments and various levels of processed science data, including expedited data sets, production data sets, and rate-buffered science data. The science network provides an operational availability of 0.98 with a MTTRS of 4 hours.

EBnet provides three options for accessing the Internet Protocol (IP)-based EBnet transport service: Local Area Network (LAN) Ethernet, LAN Fiber Distributed Data Interface (FDDI), and Wide Area Network (WAN) carrier service. Figure 3-2 shows an example of each of these types of interface/demarcation points to EBnet users.

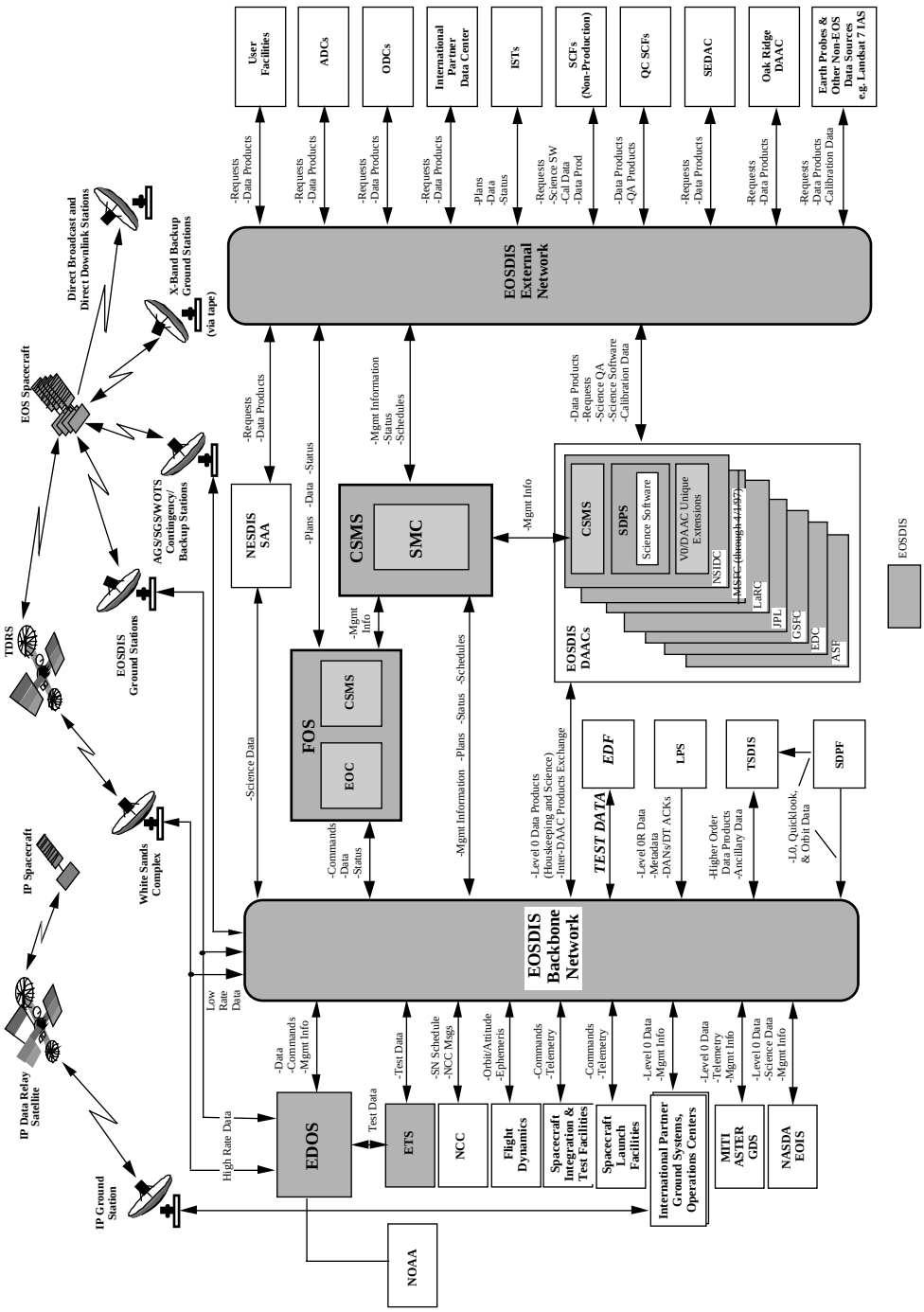

Figure 3-1. EOS Ground System

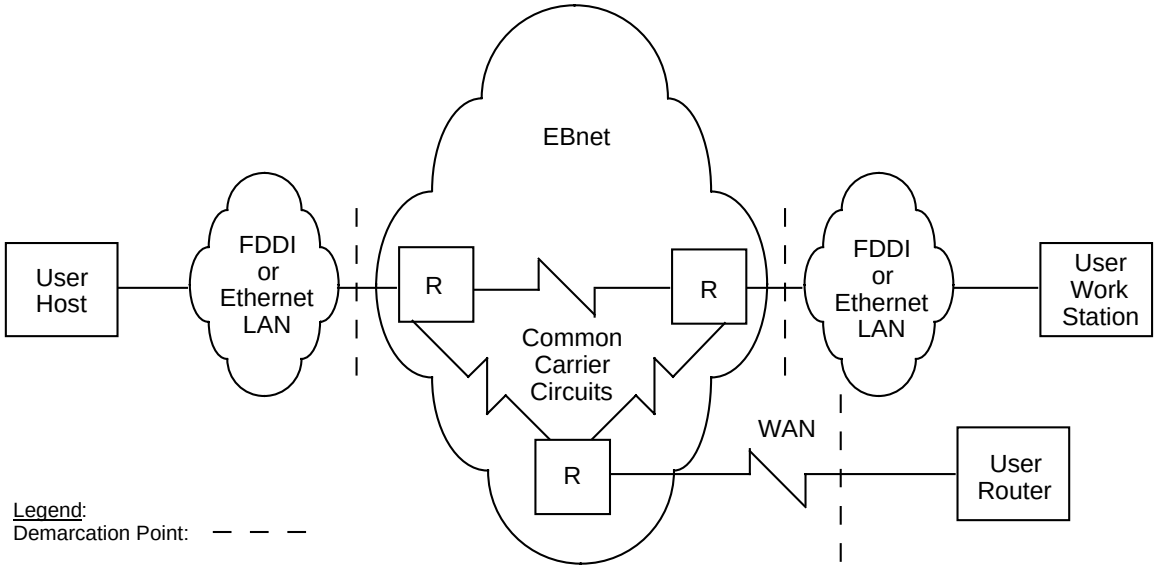

Figure 3-2. EBnet Demarcations

Sustaining engineering, preventive and remedial maintenance, and network monitoring services are provided for EBnet equipment, to ensure that EBnet keeps pace with technology and standards, and provides continuous service. The official point of contact for EBnet operational status is the Nascom Communications Manager (COMMGR) (301-286-6141). Users who detect a network problem are urged to immediately report it to the COMMGR. The COMMGR may also provide users with limited information about maintenance and status actions. Refer to the Nascom IP Operational Network (IONET) User Guide (541-225) for information regarding user connections, security guidelines, and maintenance information.

3.2 FSTB Description

The purpose of FSTB is to develop and test Command and Telemetry Interface Unit (CTIU) firmware and Spacecraft Control Computer (SCC) flight software. This is accomplished by embedding CTIU Software Development Unit (SDU) and SCC SDU in the FSTB full configuration. Other pertinent flight software is modeled by the real-time computer such as Guidance, Navigation, and Control (GN&C) models. Simulation data and control is transferred between Real-time Computer and the FSTB CTIU and SCC by the timing board, and the Command and Telemetry (C&T) Bus interface. The CTIU Low Rate System (LRS) interface is not simulated in the FSTB. CTIU command and telemetry data is transferred between the User Interface Computer and the CTIU SDU through the Input/Output (I/O) chassis via blocks of data transferred over an S11W interface. The I/O chassis provides the electrical interface required by the CTIU. Debug capabilities are provided by the SDU's Test and Monitor logic. The real-time Computer communicates with SDU Test and Monitor Logic over RS-232 interfaces. After

spacecraft flight software maintenance responsibility is transferred to Code 512, FSTB will be used to maintain the spacecraft flight software.

The FSTB includes the following functional elements:

a. Computer Equipment. This consists of the User Interface Computer and the Real-time Computer.

b. Non-Flight Spacecraft Computer Equipment. The non-flight spacecraft computer equipment consists of an SCC SDU, a CTIU CTCA SDU and a non-flight CTIU EOSDIS Core System (ECS) Technical Manager (ETM) I/O boards. The CTA SDU and CTIU ETM comprise the CTIU SDU.

c. I/O Chassis. The I/O chassis receives command transfer frames without the error control word and generates Non Return to Zero-M-encoding (NRZ-M) encoded Command Link Transmission Units (CLTUs). The I/O chassis also receives telemetry from CTIU, strips the sync word and Reed-Solomon data from Channel Access Data Unit (CADU) and forwards the remaining data to the User Interface Computer.

d. Timing Board. The timing board generates a system synchronizing interrupt and provides other interface signals required by the CTIU and SCC.

e. Power Control. Power control consists of an Alternating Current (AC) Power Control chassis and a Power Control Fault Monitor chassis to provide and monitor critical system power requirements.

f. Logic Analyzer. The logic analyzer shall consist of 102 channels of state and timing analysis, a two-channel digitizing oscilloscope and a twelve-channel pattern generator.

3.3 Relationship Between EBnet and Code 512 FSTB

The interface between the FSTB and EBnet is to support connectivity between the FSTB and the EOS Operations Center (EOC). The data flows between FSTB and EOC supported by EBnet are considered to be science traffic. (For the purpose of EBnet ICDs, any traffic type that is not real time is considered to be science traffic.) Both the FSTB and the EOC are located at GSFC. The FSTB does not require connectivity to the EBnet WAN links.

Section 4. Interface Detailed Design

4.1 Interface Design Overview

The EBnet to FSTB interface is shown in Figure 4-1. FSTB uses IEEE 802.3-compliant 10Base-T interface in Star Topology and utilizes Center Network Environment (CNE) as its external interface for communication. FSTB will place software on a server where EOC can access it for testing and other purposes. The server will be located in Building 1 at GSFC. No redundancy for this circuit is incorporated in this design as it is considered to be a test system.

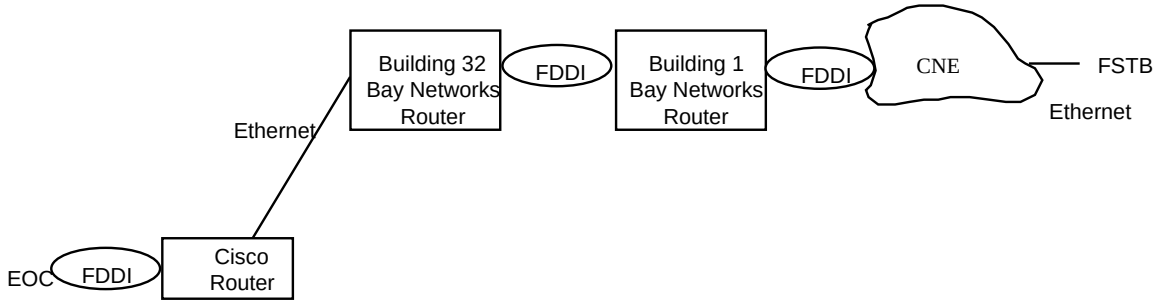

Figure 4-1. FSTB Interface

4.2 Design Assumptions

The LAN segment has an aggregate throughput of 1 megabit per second (Mbps). An Ethernet interface was chosen with 10Base-T interconnections to terminate these nodes.

4.3 Data Interface Design

The following information is known about the design of the data interface for the FSTB at GSFC. Routers provide the data communication interface for the Ethernet link to the FSTB. The protocols for each layer are described in the following paragraphs.

4.3.1 ISO Layer One Interface Control (Physical Layer)

EBnet will support the following physical layer connections:

a. IEEE 802.3 10BaseT (unshielded twisted pair) with RJ45 connectors.

b. IEEE 10Base5 (thick Ethernet, RG-8 coax, 50 ohm impedance) with 15-pin connector.

4.3.2 ISO Layer Two Interface Control (Data Link Layer)

EBnet will support the following data link layer protocols:

a. ISO 802.2 Logical Link Control (LLC).

b. ISO 8802-3 Carrier-Sense Multiple-Access with Collision Detection (CSMA/CD) Media Access Control (MAC) - Ethernet Version 2.0 is supported.

4.3.3 ISO Layer Three Interface Control (Network Layer)

EBnet will support the following network layer protocols:

a. RFC 791, Internet Protocol Version 4.0.

b. RFC 826, Address Resolution Protocol (ARP).

c. RFC 792, Internet Control Message Protocol (ICMP).

d. RFC 1112, Internet Group Multicast Protocol (IGMP).

e. Routing Protocol is not applicable to this ICD; CNE provides connection.

4.3.4 ISO Layer Four Interface Control (Transport Layer)

EBnet will support transparent communication at the transport layer.

4.3.5 ISO Layer Five Interface Control (Session Layer)

EBnet will support transparent communication at the session layer.

4.3.6 ISO Layer Six Interface Control (Presentation Layer)

EBnet will support transparent communication at the presentation layer.

4.3.7 ISO Layer Seven Interface Control (Application Layer)

EBnet will support transparent communication at the application layer.

4.3.8 Network/Station Management Protocols

EBnet shall support, at a minimum, the following management protocol:

a. SNMP.

4.4 Routing and Addressing Guidelines

EBnet will be inter networked by routers and switches which will be configured to support only the IP protocol, and will provide isolation for separate networks. Cisco 7513 routers and Bay Networks BCN routers have been chosen to provide network access to users.

EBnet will utilize standard IP addressing conventions. EBnet will provide or distribute NASA Science Internet (NI)-assigned Class C addresses to users where it is required.

FSTB uses CNE at GSFC for its external communications hence IP addresses will have to be assigned by CNE for its usage. The FSTB user is responsible to make the proper applications to the Rib Manager in the building where the unit will be located to get proper IP addresses assigned to the various interfaces within FSTB.

4.5 Performance

EBnet envisions that the data flow requirements for this ICD is well within the performance guidelines for the equipment that it expects to deploy for this circuit.

4.6 Data Flow Requirements

The data flow requirements for this circuit are within the design criteria for the equipment involved in the design of this circuit.

4.7 Equipment List

An Ethernet hub may have to be procured by FSTB for its interconnection to CNE. EBnet will provide the following equipment to support this interface.

a. Router: Cisco (Model 7513).

b. Router: Bay Networks (Model BCN).

Section 5. Facilities and Maintenance Demarcation

5.1 Equipment Location

FSTB will be located in Building 1 at GSFC. The EBnet equipment is located in Building 1, Room 53 and Building 32, Room C210H.

5.2 Maintenance Demarcation

FSTB will be attached to the CNE connection available at its location.

Abbreviations and Acronyms

ARP	Address Resolution Protocol
A/C	Alternating Current
C&T	Communications and Tracking
CADU	Channel Access Data Unit
CCB	Configuration Control Board
CCITT	International Telegraph and Telephone Consultative Committee
CLTU	Command Link Transmission Unit
CNE	Center Network Environment
COMMGR	Communications Manager
CSMA/CD	Carrier-Sense Multiple-Access with Collision Detection
CTIU	Command and Telemetry Interface Unit
DARPA	Defense Advanced Research Projects Agency
DCN	Document Change Notice
EBnet	EOSDIS Backbone Network
ECS	EOSDIS Core System
EGS	EOS Ground System
EIA	Electronic Industries Association
EOC	EOS Operations Center
EOS	Earth Observing System
EOSDIS	Earth Observing System Data and Information System
EROS	Earth Resources Observation System
ESDIS	Earth Science Data and Information System
FDDI	Fiber Distributed Data Interface
FSTB	Flight Software Testbed
GN&C	Guidance, Navigation, and Control
GSFC	Goddard Space Flight Center
I/O	Input/Output

ICD	Interface Control Document
ICMP	Internet Control Message Protocol
IEEE	Institute of Electrical and Electronic Engineers
IGMP	Internet Group Multicast Protocol
IONET	IP Operational Network
IP	Internet Protocol
IRD	Interface Requirements Document
ISO	International Organization for Standardization
LAN	Local Area Network
LLC	Logical Link Control
LRS	Low Rate System
MAC	Media Access Control
MO&DSD	Mission Operations and Data Systems Directorate
MTTRS	Mean Time to Restore Service
NASA	National Aeronautics and Space Administration
Nascom	NASA Communications
NI	NASA Internet
NMI	NASA Management Instruction
NRZ-M	Non Return to Zero-M
OSPF	Open Shortest Path First
PHY	Physical Layer Protocol
PMD	Physical Layer Medium Dependent
RARP	Reverse Address Resolution Protocol
RFC	Request for Comment
RIP	Routing Information Protocol
SCC	Spacecraft Control Computer
SDU	Software Development Unit
SNMP	Simple Network Management Protocol
WAN	Wide Area Network